

# First records of three exotic giant mantid species on the Croatian coast

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## Abstract

Some giant mantid species of the genera *Sphodromantis* Stål, 1871 and *Hierodula* Burmeister, 1838 have been found spreading their distribution through the Palearctic, but none of the species have been recorded from the Adriatic coast of Croatia, where numerous local species already co-exist, such as *Mantis religiosa* (Linnaeus, 1758) and *Iris oratoria* (Linnaeus, 1758). In this study, we present the first records of the giant African mantis (*Sphodromantis viridis* (Forskål, 1775)), the Indochina mantis (*Hierodula patellifera* Serville, 1839), and the giant Asian mantis (*Hierodula tenuidentata* Saussure, 1869) from Croatia. A small population of *S. viridis* was observed in the southernmost county of Croatia (Dubrovnik); a single record of *H. patellifera* comes from the westernmost part of the country (Istria), while the first two specimens of *H. tenuidentata* were observed in the central part of the Croatian coast (Šibenik). These alien species represent three new taxa for the mantid fauna of Croatia, which now counts 9 or 10 species (depending on inclusion of *Ameles heldreichi* Brunner von Wattenwyl, 1882). The fast spreading of these species in Europe proves their adaptation to regions where they have arrived; thus, future monitoring of the species must be conducted in order to determine their impact on native fauna.

## Keywords

alien, allochthonous, Dubrovnik, Europe, *Hierodula patellifera*, *Hierodula tenuidentata*, Istria, Mantodea, new records, Šibenik, *Sphodromantis viridis*, spreading

## Introduction

Mantids are large predatory insects, so people have been observing them from prehistory (Battiston et al. 2010, Kolnegari et al. 2020). More than 2500 species are known (Otte et al. 2021), with the greatest diversity being in the tropical regions (Schwarz and Roy 2019, Otte et al. 2021). Mantid fauna of the Western palearctic consists of about 130 species (Battiston et al. 2010), while, for example, Vietnam is home to almost 70 species (Shcherbakov and Anisyutkin 2018). Few species are shared between tropical and temperate regions; this study shines the spotlight on three.

Until now, small Croatian Mantodea fauna consisted of seven species belonging to five genera (*Ameles* Burmeister, 1838, *Empusa* Illiger, 1798, *Geomantis* Pantel, 1896, *Iris* Saussure, 1891 and *Mantis* Linnaeus, 1758) (Rebrina et al. 2014), but the giant African mantis (*Sphodromantis viridis* (Forskål, 1775)), the Indochina mantis (*Hierodula patellifera* Serville, 1839), and the giant Asian mantis (*Hierodula tenuidentata* Saussure, 1869) are expected to spread into the country soon. *S. viridis* is widespread in the sub-Saharan region and is known to be very adaptable to different kinds of environments, including anthropized ones (Battiston et al. 2020a). In Europe, it was known only from Southern Spain (Bolívar 1876, Gangwere and Morales Agacino 1970) until it was recorded in Mallorca (Canyelles and Alomar 2006) and in Central Spain (Cabanillas 2017) and eventually Portugal (Marabuto et al. 2014, Oliveira and Ferreira 2019), France (Battiston et al. 2020a), Italy (Battiston et al. 2017, 2019, 2020a), and Greece (Battiston et al. 2020a). On the other hand, *H. patellifera* and *H. tenuidentata* are native to Asia. The first European records of the former species date back to 2013 in Southern France (Moulin 2020) and 2015 in Italy (Battiston et al. 2020a); the earliest European record of the latter was from Crimea (Werner 1916), where it was rediscovered 100 years later. It is now widespread along the entire coast of the peninsula, from where it started its expansion northwards in other parts of Ukraine (Pushkar and Kavurka 2016). Soon after, European records of *H. tenuidentata* began to be reported frequently. Today, the species is known to be present in Bulgaria and Greece (Romanowski et al. 2019), Albania (van der Heyden 2018), Italy (Battiston et al. 2018), North Macedonia (Cianferoni et al. 2018), Serbia (Vujić et al. 2021), and Romania (Pintilioaie et al. 2021). This study provides further insight into the spread of these species in Europe.

## Materials and methods

*Hierodula patellifera* finding.—A single female was found in Novi-grad (Istria) on a palm tree near a road edge. The specimen was photographed and uploaded to Biologer (an open platform for collecting biodiversity data) (Popović et al. 2020).

*Hierodula tenuidentata* findings.—Two adult specimens were observed and photographed in the garden center “Dubrava” in Dubrava near Šibenik.

*Sphodromantis viridis* findings.—In early November 2020, an adult male was attracted to the terrace light of a family home on Lapad peninsula in Dubrovnik. The specimen was collected, dry pinned, and deposited in the Dubrovnik Natural History Museum (DNHM). When preparation of the manuscript began based on this single male, the authors were convinced that the male individual represented the only record until it was decided to search the surrounding area for oothecas. Archival photos revealed sighting of a spherical ootheca from November 2019 observed on *Nerium oleander* L. in a camping area close to where the adult male was collected. The camping area (Fig. 4G) was visited again in March 2021, and another ootheca was found.

*Online records*.—iNaturalist was searched for specimens that could represent *Sphodromantis* or *Hierodula* specimens, and a single photograph depicting a nymph unidentifiable to species level was found (<https://www.inaturalist.org/observations/53351490>).

*Identification and systematics*.—The collected specimens were identified based on the morphological characteristics described in Battiston et al. (2019, 2020b). At first glance, giant mantids of the genera *Sphodromantis* and *Hierodula* can be distinguished from the native, similarly sized *Iris oratoria* (Linnaeus, 1758) or *Mantis religiosa* (Linnaeus, 1758) by the presence of white-colored stigmas on the tegmina (Figs 2A, 3A, 4C). Both species of the genus *Hierodula* spreading through Europe (*H. patellifera* and *H. tenuidentata*) have three dark-colored horizontal lines on the ventral part of the thorax (Fig. 2B), which are absent in *S. viridis* (Fig. 4A). Additionally, differences exist in the shape and length of the pronotum, which is long and thin in *Sphodromantis* (Fig. 4B) but short and ovoidal in *Hierodula* (Fig. 3A). The two *Hierodula* species may be separated by the morphology of the inner margin of the anterior coxa. In *H. patellifera*, it is equipped with yellowish spines with basal plates (Fig. 2B, C), while basal plates are absent in *H. tenuidentata* (Fig. 3B). The higher systematics follow Battiston et al. 2010, while species nomenclature follows the Mantodea species file (Otte et al. 2021). In the literature, *H. tenuidentata* is sometimes reported under its synonym, *T. transcaucasica*. Most probably, *H. tenuidentata*

A

***Ameles decolor***

B

***Ameles spallanzania***

C

***Geomantis larvoides***

D

***Mantis religiosa***

Fig. 1. Native Croatian Amelidae and Mantidae representatives and their distribution areas in Croatia. A. *Ameles decolor*; B. *Ameles spallanzania*; C. *Geomantis larvoides*; D. *Mantis religiosa*. (Photo credit A, B. Gernot Kunz; C. Radomir Jaskula; D. Matea Martinović).

represents a single species distributed from India to Europe (Battiston et al. 2018).

## Results

### Order Mantodea

#### Family Mantidae Burmeister, 1838

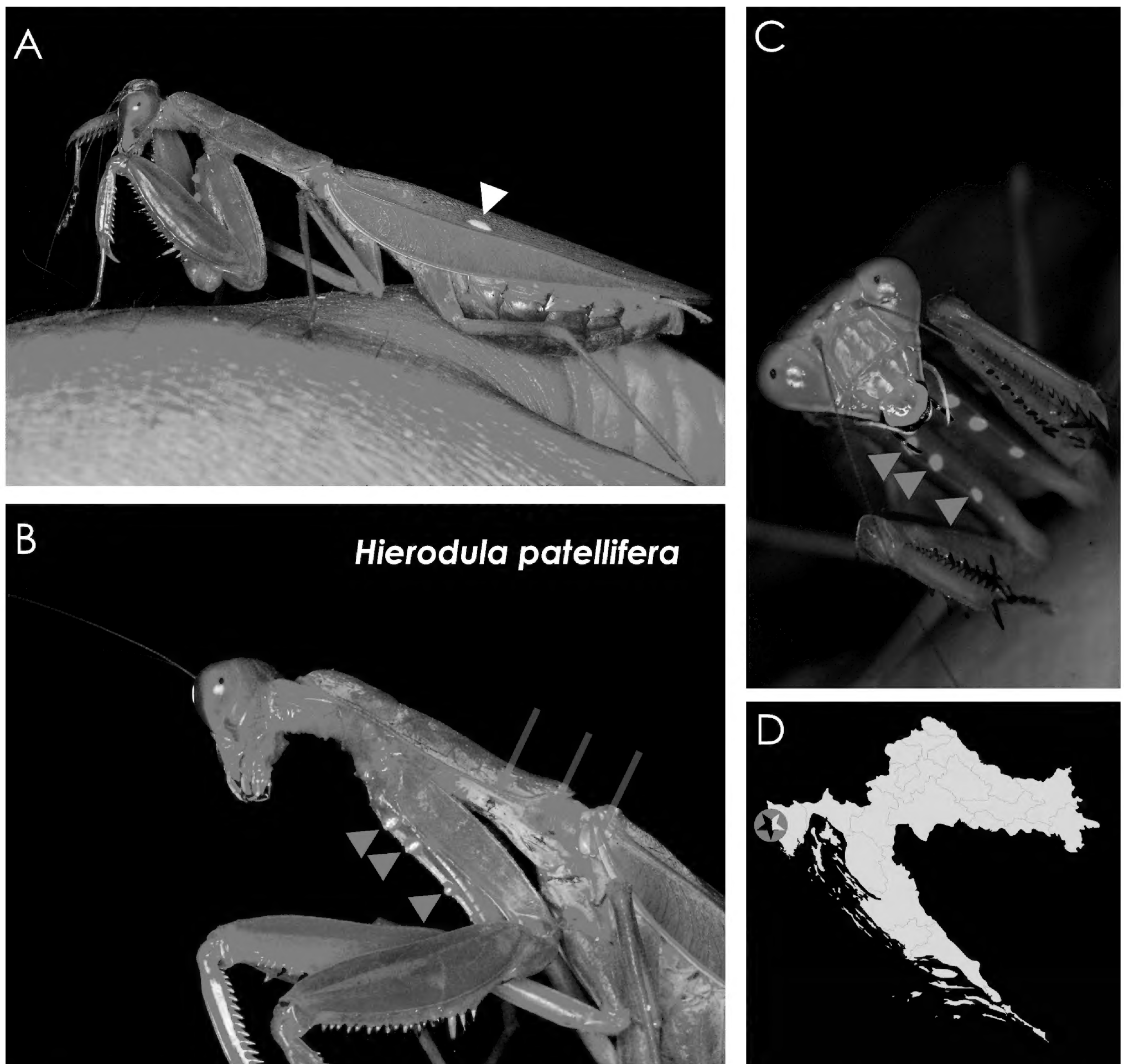
*Composition and distribution in Croatia.*—Hitherto, at least four species belonging to three genera (*Ameles*, *Mantis*, *Geomantis*) have been reported from the country (Rebrina et al. 2014). In current taxonomy (Schwarz and Roy 2019), *Ameles* belongs to Amelidae; thus, it is

no longer included in Mantidae, so the following checklist includes members of both families in the Croatian fauna. Distribution follows data from Rebrina et al. (2014), GBIF (2021), and iNaturalist (2021). This study presents the first records of members of two more genera, *Hierodula* and *Sphodromantis*, found to be present in Croatia.

#### Checklist of genera and species of Croatian Amelidae and Mantidae with new records of alien taxa

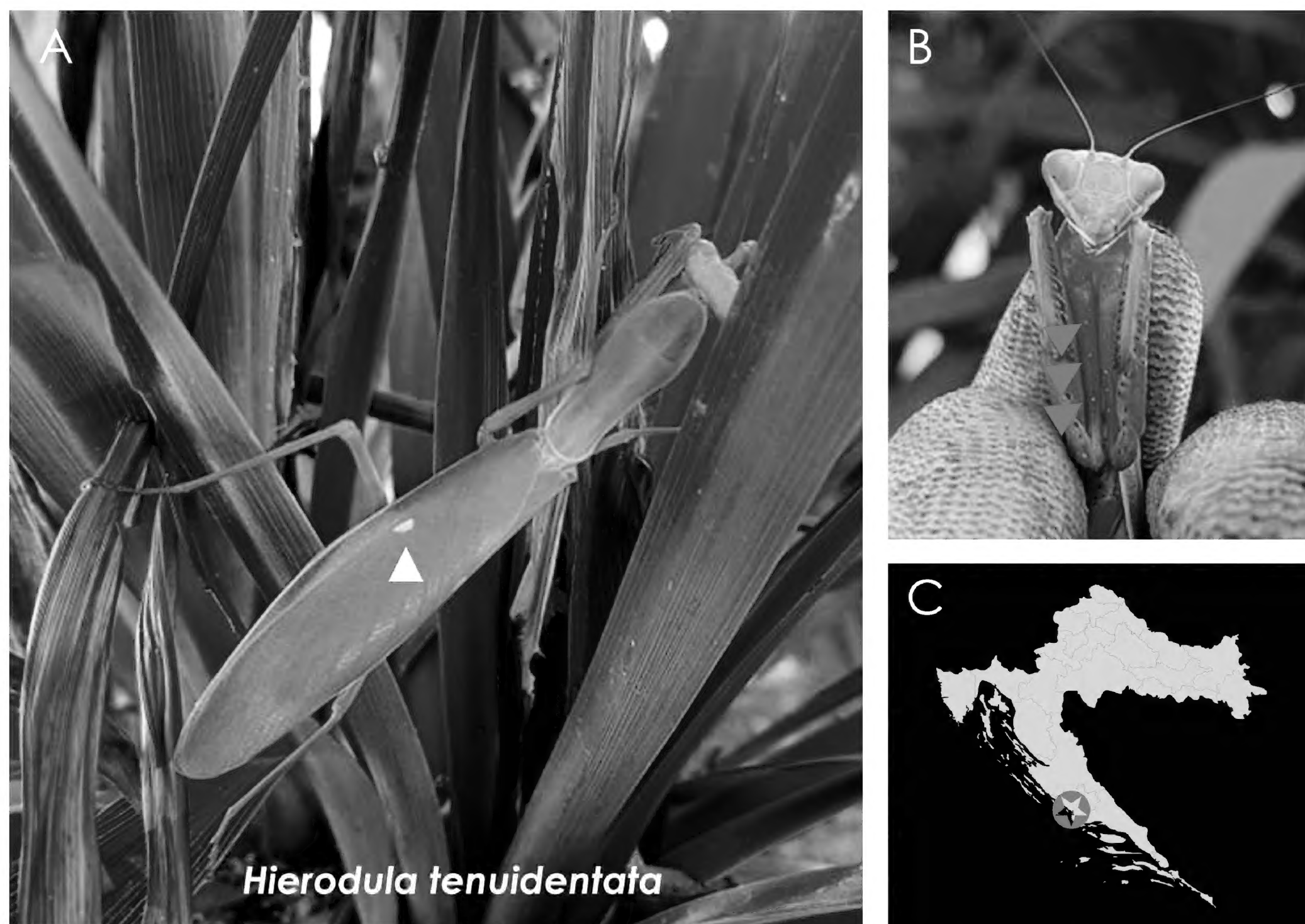
##### Genus *Ameles* Burmeister, 1838

Species *A. decolor* (Charpentier, 1825) (Fig. 1A), common in the Adriatic and Dinaric regions.



**Fig. 2.** *Hierodula patellifera* Serville, 1839, female. A. Presence of the white-colored stigma on the tegmina; B. Lateral view, yellow spines with basal plates on the anterior coxa and dark-colored horizontal lines on the ventral part of the thorax; C. Frontal view, yellow spines with basal plates on the anterior coxa; D. Map with locality of the first Croatian record, western-most part of the Adriatic coast. Photo credit: Marko Lengar.





**Fig. 3.** *Hierodula tenuidentata* Saussure, 1869, female. A. Dorsal view, presence of white-colored stigma on the tegmina, pronotum; B. Ventral view, yellow spines without basal plates on the anterior coxa; C. Map with locality of the first Croatian record, central part of the Adriatic coast. Photo credit: Sebastian Čato.

\*\* Species *A. heldreichi* Brunner von Wattenwyl, 1882, could be present in the far south. Presence of *A. heldreichi* in the Adriatic coast is doubtful (M. Villani, pers. comm.). Shape of the eyes is unreliable diagnostic trait, so the reports of *A. heldreichi* from Croatia are questionable; all records should be regarded as *A. decolor*.

Species *A. spallanzania* (Rossi, 1792) (Fig. 1B), common in the Adriatic and Dinaric regions.

#### Genus *Geomantis* Pantel, 1896

Species *G. larvoides* Pantel, 1896 (Fig. 1C), known only from Dubrovnik Area.

#### Genus *Hierodula* Burmeister, 1838

Species *H. patellifera* Serville, 1839, newly reported for the country (Fig. 2)

*First record for Croatia.*—1♀; Istria County: Novigrad: Dajla, residential area [45°21'05.7"N, 13°32'42.8"E], 6 m a.s.l., 21.XI.2020, obs. M. Lengar.

Species *H. tenuidentata* Saussure, 1869, newly reported for the country (Fig. 3)

*First record for Croatia.*—1♀ and 1♂; Šibenik-Knin County: Šibenik: Dubrava kod Šibenika, Garden center "Dubrava" [43°44'08.7"N, 15°56'46.4"E], 84 m a.s.l., 21.VIII.2021, obs. S. Čato.

#### Genus *Mantis* Linnaeus, 1758

Species *M. religiosa* (Linnaeus, 1758) (Fig. 1D), widespread in whole country.

#### Genus *Sphodromantis* Stål, 1871

Species *S. viridis* (Forskål, 1775), newly reported for the country (Fig. 4).

*First records for Croatia.*—(1/3) ootheca (Fig. 4D), Dubrovnik-Neretva County: Dubrovnik: Lapad peninsula, camping area [42°39'47.7"N, 18°04'11.8"E], 23 m a.s.l., 11.XI.2019, obs. M. Martinović; (2/3) ootheca (Fig. 4E), same place as the first one, 26.III.2021, obs. M. Martinović; (3/3) 1♂ Dubrovnik-Neretva



Fig. 4. *Sphodromantis viridis* (Forskål, 1775), male. A. Absence of the dark-colored horizontal lines on the ventral part of the thorax; B. Pronotum; C. Presence of the white-colored stigma on the tegmina; D. Ootheca from 2019; E. Ootheca from 2021; F. Map with locality of the first Croatian record, southernmost part of the Adriatic coast; G. Camping area and habitat where small population of *S. viridis* was established. Photo credit: Matea Martinović.

County: Dubrovnik: Lapad, residential area, [42°39'39.5"N, 18°04'42.1"E], 12 m a.s.l., 3.XI.2020, obs. & coll. M. Martinović.

*Taxa not identified to species level.*—Besides the new records identified to species level, a juvenile specimen was observed on 13<sup>th</sup> July

2020 by Dennis Aagaard in a small tourist area called Zaton near Zadar; the photo was published on iNaturalist (observation number 53351490). The nymph in the photo has its abdomen bended at an angle of 90°, which is a diagnostic character related to the juvenile stages of both *S. viridis* and *Hierodula* species. Nymphs of



*M. religiosa* have the abdomen held parallel to the ground from the first to the last moult (Battiston et al. 2019). Although not identifiable to the species level from the photo, this record signals the possibility that *H. tenuidentata* Saussure, 1869 is already widespread in Dalmatia. More records are anticipated soon.

## Discussion

Finding a single male of an allochthonous mantid species could be overlooked, but finding two oothecae at the same place two years apart suggests that a small population of *S. viridis* has been established in Southern Croatia (Fig. 4F). Dubrovnik is on the itineraries of many cruise ships, and it is included in both Western and Eastern Mediterranean cruise routes. During their round-trip excursions, some cruise ships visit several port cities in southern Spain, France, Italy, Cyprus, Turkey, and Greece, which are already inhabited by *S. viridis*, before arrival in Dubrovnik. The cruise-ship route probably served as a pathway of introduction for *S. viridis* to Croatia. The locality where the small population of *S. viridis* was recorded is situated on the Lapad peninsula, right at the entrance to the Port of Dubrovnik. The species is likely attracted to the lights of ships staying the night in the Mediterranean ports within the species' distribution area; in this way, they arrive in Dubrovnik as a blind passenger, either from the western Mediterranean (Southern Spain) or from the Middle East (Cyprus, Turkey). This hypothesis is in accordance with insights on the human-assisted speed of expansion of *S. viridis* across the Mediterranean region (Battiston et al. 2020a). However, there are many other plausible causes. For example, oothecae may have come attached to plants or other commercial goods or attached to tourists' cars or personal items. Finding two specimens of *H. tenuidentata* in the garden center "Dubrava" in Dubrava near Šibenik (Fig. 3C) adds credence to the possibility of human-assisted expansion of this species in Europe, as the garden center sells plants imported from various areas in Italy where *H. tenuidentata* is known to be present (Battiston et al. 2018). Unfortunately, a lack of evidence means we can only propose hypotheses to be tested by future dispersals within the region. We will continue to monitor the garden center in order to assess whether the species already has the population established.

As in France and Italy where individuals of *H. patellifera* were observed mainly on trees (Battiston et al. 2020b, Moulin 2020), the female specimen found in late November 2020 on a palm tree is further confirmation of the arboreal habits of this species. The arrival of *H. patellifera* in the westernmost part of the Croatian Adriatic (Fig. 2D) is likely a result of natural dispersal from the neighboring Northern Italy where several fragmented and reproducing sub-populations exist (Battiston et al. 2020b).

There is currently no evidence of invasive behavior from these alien species. However, they have only been present for a short period, and their impact on local fauna should be determined by detailed research conducted over the span of many years. Comparative studies are needed to determine whether *Hierodula* and *Sphodromantis* represent direct competition to *Mantis*, *Iris*, or *Empusa*. *Sphodromantis* is not expected to spread much, as it prefers habitats influenced by the Mediterranean climate. *Hierodula* species are, however, expected to spread more, considering that *H. tenuidentata* is already surviving the cold Pannonian winters in Serbia (Vujić et al. 2021). On the other hand, the native area of distribution of *H. patellifera* includes localities with similar climate, such as that of Northern Italy and Central Europe (Battiston et al. 2020b). Thus, *Hierodula* can be expected to colonize the Mediterranean, Pannonian, and the Dinaric region.

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